Use of GPM Data to Develop and Validate Rainfall Algorithm From Geostationary Satellites Over The Pacific Region

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Background

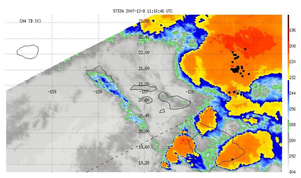
Precipitation estimates from geostationary satellites provide the rapid temporal update desired by the operational meteorologists to capture the growth and decay of precipitating cloud systems on a scale of several kilometers. The launch of the Geostationary Operational Environmental Satellite GOES-16 ushered a new era of geostationary satellite with the 16 channel Advanced Baseline Imager (ABI) and the Geostationary Lightning Mapper (GLM) and the ability to take full-disk images of Earth at five-minute intervals. This project investigates the development, evaluation, and application geostationary satellite Quantitative Precipitation Estimates (QPE) for the US National Weather Service Pacific Region. JMA's Himawari-8 Advanced Himawari Imager (AHI) and ground lightning network GLD360 lightning observations data are being used as GOES16 proxy data for the Pacific region.

The approach to inferring precipitation from geostationary Imager observations initially relate lightning information and infrared observations of cloud tops (Adler and Negri, 1988; Xu et al., 2013, 2014) to instantaneous and convective rainfall amounts over the Pacific region. However, these techniques are deficient in detecting stratiform precipitation that are common for the tropical cyclones and warm rain bands in the Pacific region. These clouds are characterized by relatively warm cloud top temperature and more homogeneous spatial distribution of cloud-top temperature that do not differ significantly between raining and non-raining regions. Studies in the recent years have shown that cloud properties, such as cloud phase, cloud water path, and cloud top height may be deduced by combining channels of different absorption and scattering characteristics. We are currently looking into methods of combining different channels on AHI to detect and estimate rainfall over the Pacific region. GPM data are used as reference precipitation information. We collected 2 years of GPM Microwave Imager and Dual-frequency Precipitation Radar KuPR, Himawari-8 AHI, and GLD360 for analysis and algorithm development.

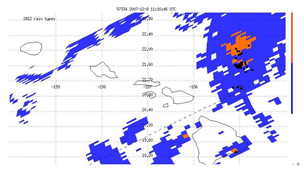
Channel and Spectral Type on TRMM VIRS, Himawari-8 and 9, and GOES-16 Imager

CHANNEL	TRMM VIRS	Himawari-8 and 9 AHI	GOES-16 ABI	SPECTRAL TYPE
1		470 nm	470 nm	Visible
2		510 nm	640 nm	Visible
3	630 nm	644 nm	860 nm	Near-IR
4		860 nm	1.37 μm	Near-IR
5	1.60 μm	1.61 μm	1.60 μm	Near-IR
6		2.26 μm	2.20 μm	Near-IR
7	3.75 μm	3.90 μm	3.90 μm	Shortwave Window (IR)
8		6.185 μm	6.20 μm	Water Vapor (IR)
9		6.95 μm	6.90 μm	Water Vapor (IR)
10		7.40 μm	7.30 μm	Water Vapor (IR)
11		8.50 μm	8.40 μm	IR
12		9.61 μm	9.60 μm	Ozone (IR)
13	10.80 μm	10.35 μm	10.30 μm	IR
14		11.20 μm	11.20 μm	IR
15	12.0 μm	12.30 μm	12.30 μm	IR
16		13.30 μm	13.30 μm	CO_2 Longwave (IR)

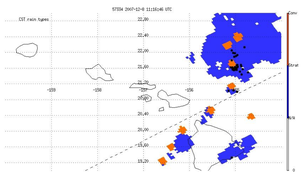
Rain Estimation From TRMM VIRS 10.8 μm Over Hawaii



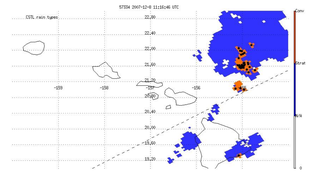
10.8μm TB, black dots are LIS lightning flashes



TMI 2A12 convective/stratiform Classification (red: convective; blue:stratiform)



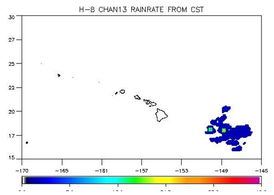
10.8 μm Convective stratiform Technique (Adler and Negri, 1988; Xu et al., 2014) (red: convective; blue:stratiform)



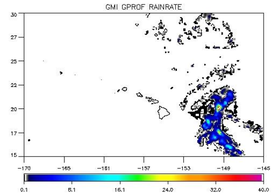
10.8 μm Convective stratiform Technique + Lightning (Xu et al., 2014) (red: convective; blue:stratiform)

Rain Estimation from Himawari-8 AHI 10.35 μm Near Hawaii

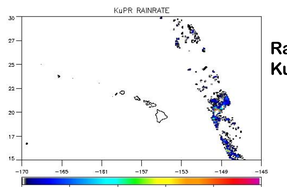
Additional Cloud Information From Multiple Channel Combinations



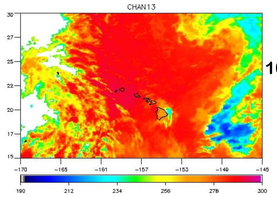
rainrate from 10.35 μm Convective stratiform technique



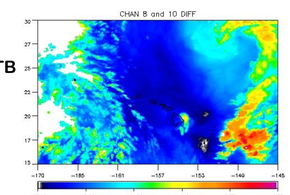
rainrate from GMI GPROF



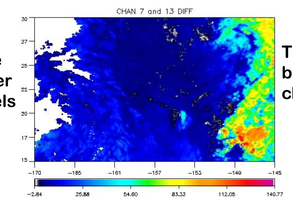
Rainrate from KuPR



10.35μm IR TB



TB difference between water vapor channels



TB difference between IR channels

Summary and Future Work

- GPM provides invaluable quantitative precipitation information for the training of geostationary imager rain estimation over the vast Pacific Ocean.
- Cloud property information deduced from various channel combinations show potential benefits to delineate rain and non-raining areas and differentiate rain intensity.
- Methodology to extract precipitation from geostationary multi-channel imager in hurricanes, shallow convective, stratiform, and warm rain conditions are currently being investigated.

REFERENCES

- R.F.Adler and AJ Negri, 1988: A satellite Infrared Technique to Estimate Tropical Convective and Stratiform Rainfall, *J. Appl. Meteorol*. 27, 30-51
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- Xu,W, R.F.Adler, and N.-Y. Wang, 2014: Combining Satellite Infrared and Lightning Information to Estimate Warm Season Convective and Stratiform Rain, *J. Appl. Meteo.Climatol.*,doi:10.1175/JAMC-D-13-069.1

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